Preclinical competency in scaling/root planing: comparing dental and dental hygiene student's outcomes

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Abstract: Dental students in Zurich receive 8.5 hours of preclinical training in scaling/root planing. Dental hygiene students receive a multiple of this amount. This study was undertaken to assess the students' acquired preclinical competencies and to what degree they may differ. 34 undergraduate dental students and 20 dental hygiene (DH) students from two different schools in Zurich were tasked with scaling/root planing a maxillary left canine, coated with black lacquer from the apex to ca. 5 mm above the cemento-enamel junction, after completing their preclinical periodontal instrumentation course. The students were allowed to use any instrument in their set (Gracey or universal curettes) for a 5-minute period. Positive (experienced DHs) and negative (laypeople) control groups performed the same task. After instrumentation, teeth were scanned and planimetrically assessed. The percentage of cleaned tooth surface was calculated and statistically analysed (Kruskal-Wallis rank sum test, Conover's test for pairwise comparisons). The dental students achieved the highest median cleaning efficacy (80.6%), followed by the experienced DHs (65.3%), the DH students (62.0%) and the laypeople (26.7%). When split by schools, a significant difference in instrumentation efficacy by the student DHs was seen ($p < 0.001$). Despite their limited instruction time, the dental students acquired preclinical scaling/root planing skills comparable to, or better than, DH students with more training time.

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SUMMARY
Dental students in Zurich receive 8.5 hours of preclinical training in scaling/root planing. Dental hygiene students receive a multiple of this amount. This study was undertaken to assess the students' acquired preclinical competencies and to what degree they may differ. 34 undergraduate dental students and 20 dental hygiene (DH) students from two different schools in Zurich were tasked with scaling/root planing a maxillary left canine, coated with black lacquer from the apex to ca. 5 mm above the cemento-enamel junction, after completing their preclinical periodontal instrumentation course. The students were allowed to use any instrument in their set (Gracey or universal curettes) for a 5-minute period. Positive (experienced DHs) and negative (laypeople) control groups performed the same task. After instrumentation, teeth were scanned and planimetrically assessed. The percentage of cleaned tooth surface was calculated and statistically analysed (Kruskal-Wallis rank sum test, Conover's test for pairwise comparisons). The dental students achieved the highest median cleaning efficacy (80.6%), followed by the experienced DHs (65.3%), the DH students (62.0%) and the laypeople (26.7%). When split by schools, a significant difference in instrumentation efficacy by the student DHs was seen ($p < 0.001$).
Despite their limited instruction time, the dental students acquired preclinical scaling/root planing skills comparable to, or better than, DH students with more training time.

Introduction

Manual dexterity is a necessity for success in the performance of scaling/root planing. Further, an understanding of periodontal pathology, root surface anatomy, the biological healing process, instrument design and adaptation to root surfaces and the mechanics of "the working stroke" (blade angulation and movement on the root surface) are needed. These principles are taught to dental and dental hygiene students, first in a skills lab on mannequin heads fitted with plastic teeth, where students practice and master basic periodontal instrumentation, and later with practical application, on patients, in a clinical environment.

The initial use of typodont models, fixed in mannequin heads, for learning scaling/root-planing skills is an established practice, to ensure that a safe and effective application of potentially harmful instruments is learned prior to their use in patient treatment. The length of time devoted to learning these manual skills in the various curricula varies greatly. Dental students in general receive less hours of preclinical periodontal instrumentation instruction than dental hygiene students. The 8.5 hours provided in the University of Zurich Dental School curriculum, compared to 64 to 80 hours devoted to practice in the skills lab at the two dental hygiene schools in Zurich, is in line with reports from other schools where the educational process has been studied (Wilson et al. 1985; Rich et al. 2005).

Competency in hard and soft deposit removal, the accepted end points in non-surgical periodontal treatment, is practiced with the removal of a proxy substance on the plastic root surfaces of the typodont models. This substance is often nail polish (lacquer), which provides good adherence and good visual feedback when the teeth are inspected outside of the model. The development of the fine motor skills needed to navigate the small surface areas to be instrumented, without damaging the surrounding tissues, is the defining endpoint for the skills lab and advancement to treating patients in clinic.

Different students develop different levels of competency over different lengths of time. Given the curriculum constraints, however, all students must reach at least a minimal level of preclinical competency to progress to patient treatment and remain in school. However, minimal qualification is never the goal of a quality education. Moreover, the emphasis today is on problem-based learning (Rich et al. 2005; Bassir et al. 2014). The question then arises: is the time allotted to learning manual scaling/root-planing skills congruent with a quality education? Moreover, can the dental students, who receive only a fraction of the practice time in skills lab, achieve the same level of competency as do the dental hygiene students, who spend a longer length of time practicing these skills? It was our hypothesis that the great disparity in periodontal instrumentation training time would be reflected in the students' end results when scaling/root planing a test tooth displaying simulated periodontal pathology.

Materials and Methods

Experimental procedure

Thirty-four volunteer undergraduate dental students (group 1) and twenty volunteer dental hygiene (DH) students (group 2) from two different schools in Zurich (groups 2a and 2b, n = 10 each) were tasked with scaling/root planing a maxillary left canine on typodonts (Fig. 1; frasaco GmbH, Tettnang, Germany) displaying identical periodontal defects: mesial horizontal defect of 6 mm; Stillman's cleft of 8 mm from the cemento-enamel junction to the gingival margin and 1 mm PPD on the facial aspect; and a PPD of 7 mm palatinal. The dental students had completed 8.5 hours of preclinical periodontal instrumentation training while the DH students had completed 80 hours (group 2a) and 64 hours (group 2b) in their respective training courses. A positive control group (experienced dental hygienists, n = 8) and a negative control group (laypeople with no experience handling dental instruments, n = 8) also participated in the study.

All students had been trained with identical hand instrument sets (Gracey 5/6, 7/8, 11/12, 13/14, Deppeler M23A universal curette) and were allowed to use any instrument(s) of their choice for a 5-minute period. The experienced dental hygienists needed no instruction to accomplish this task, while the laypeople were shown the cutting edges of the instruments, explained the goal of the exercise, and then set to work for the same 5-minute period. All test teeth had been coated with black nail polish (Manhattan, COTY Germany GmbH, Mainz) from the apex to ca. 5 mm above the cemento-enamel junction. After instrumentation, the test teeth were removed, scanned (Hewlett Packard C1757A, Houston Texans, USA) and planimetrically compared to a reference tooth (positive control) that had been previously scaled outside of the typodont model by one of the authors (DH, Fig. 2).

Fig. 1 Scaling a maxillary left canine on a typodont model

Planimetric evaluation of the scaled teeth

The anonymously collected test teeth were successively fixed on a REM carrier and positioned on a guide trail to generate a three-dimensional image. The images were digitalized and the percentages of surfaces with residual nail lacquer measured planimetrically from 5 mm above the cervix (area corresponding to the cemento-enamel junction) to the apex of the tooth. A mask for the reference tooth, with a greyscale threshold of 157, was used as a basis for comparison with the resulting greyscale images of the test teeth, under the guidance of custom-made greyscale recognition software. This mid-grey threshold value, on a black to white scale of 0 to 255, was selected to filter out any background scatter and only evaluate the dark pixels scanned from any residual black lacquer on tooth surfaces which could have possibly been cleaned.

Statistical analysis

The percentage of cleaned tooth surface was calculated and statistically analysed using the Kruskal-Wallis rank sum test, followed by Conover's *post-hoc* test for pairwise comparisons,

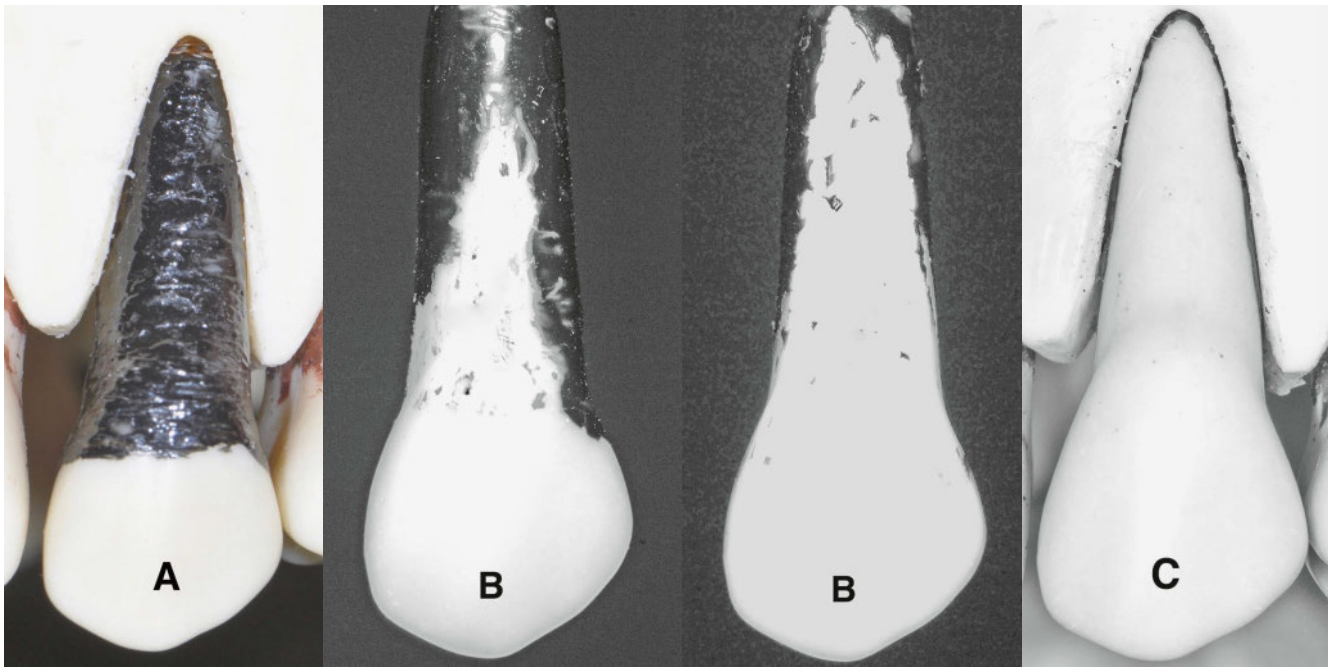

Fig. 2 Typodont teeth: A) before concrement removal, B) examples of student scaled teeth, C) the reference tooth, scaled under direct vision

with the Holm adjustment for multiple testing. Calculations were performed with the statistical software R, version 3.2.2 (R Core Team 2014) and the PMCMR package (Pohlert 2014).

Ethic review board approval

The local ethic review board reviewed the study design (BASEC-Nr. Req-2017-00492), found it to be exempt from the Swiss Human Research Laws and provided a certificate of non-objection. All participants in this study were informed of the purpose and scope of the study prior to expressing their willingness to take part in the evaluation of their scaling/root-planing skills. The participants were assured that the data collected would be anonymized and specifically for the dental students, should they elect to not take part in the study, that there would be no prejudice in terms of grading for the periodontal skills lab. Moreover, no compensation was offered for participation in this study.

Results

The dental students achieved the highest median cleaning efficacy (80.6%). The DH students reached a median level of 62.0% when examined as a whole (Fig. 3a). However, when the DH cohort was split according to the school attended, the students in group 2a reached a median level of 79.5%, while those in group 2b achieved a median level of 52.0% (Fig. 3b). The experienced DHs achieved a median cleaning efficacy of 65.3% while the lay participants had a median cleaning efficacy of 26.7%. The reference tooth, cleaned under direct vision, was scanned ten times and displayed a median lacquer removal value of 96.7%. The Kruskal-Wallis rank sum test showed a statistically significant difference in cleaning efficacy between the different groups. The Conover's test for pairwise comparisons showed no significant difference between the group mean ranks for the dental students and the DH students in group 2a. The DH students in group 2b achieved significantly lower cleaning efficacy levels ($p < 0.001$) than those achieved by the dental students and the DH students in group 2a.

Discussion

Based on the results of this study, our hypothesis that periodontal instrumentation training time would be reflected in the students' end results when scaling/root planing a test tooth, displaying simulated periodontal pathology, must be rejected. In fact, the dental students displayed scaling/root-planing skills comparable to the DH students who received 80 hours of training, and even achieved better results than the DH students who received 64 hours of training. These results were not expected, as the shortest training time found in a previous study (15 to 20 hours) (Heasman & Preshaw 2015) was still twice as long as the training time provided to the dental students in the current study.

Although this study did not test for confounding factors such as age, educational background, or sex of the students, previous studies have examined these factors explicitly (Wilson 1985) and implicitly (Lobene et al. 1974; Sisty et al. 1978) and have not found them to be relevant to skill levels attainable. Rather, learning curves appear to be, on average, dependent upon the anatomy and accessibility of the tooth to be instrumented (Rühling et al. 2002), previous coursework which develops fine motor skills (such as dental morphology, preclinical operative dentistry and dental materials) and perhaps learning efficiency associated with longer academic experience (Wilson et al. 1985).

Both the dental and the DH students in this study received similar preclinical instruction, using the same instruments for the removal of simulated concrement (nail polish) on identical (group 2a) or similar (group 2b) typodont models. All the students received their instruction at the beginning of their preclinical coursework. Moreover, the dental students had received no previous hand or rotary dental instrument training.

Because the DH education in Switzerland is not provided at University or College level, there is an obvious discrepancy between the educational backgrounds of the DH and dental students. The dental students must have successfully completed

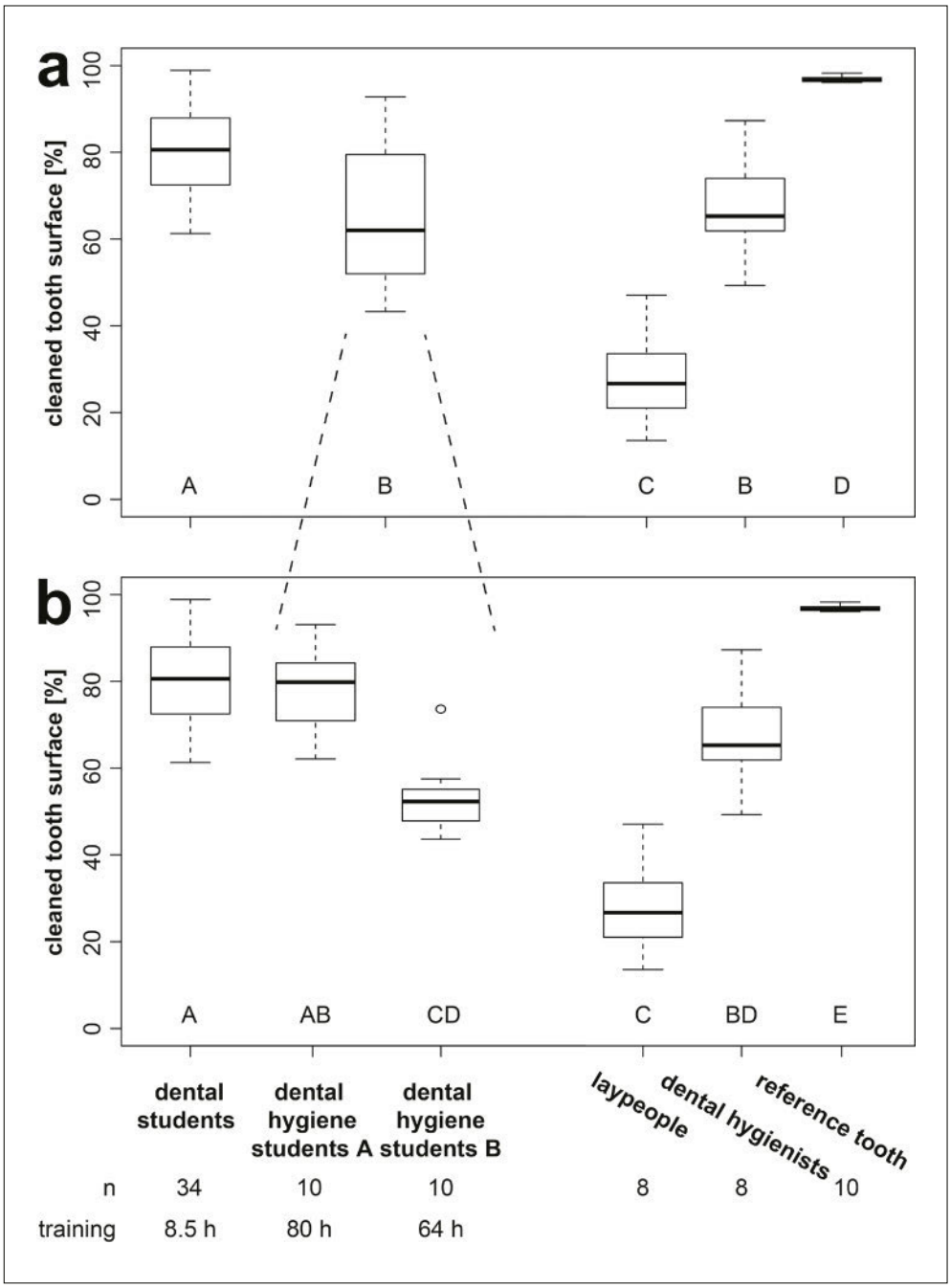

Fig. 3 a) Median cleaning efficacy b) Median cleaning efficacy, when the DH student cohort is split by school. Differing upper case letters represent significant differences between the group results ($p < 0.01$).

five years of (higher level) secondary education to obtain admission into the University and have completed two years of undergraduate coursework before entering the dental school. In contrast, the DH students have three years of (lower level) secondary education and completed an apprenticeship (usually as a dental assistant) before being eligible for admission in to DH school. The academic challenges previously mastered by the dental students, and an acquired ability for efficient learning and knowledge/skills transfer, may be one reason that they scored so high in this manual test despite very limited training time. However, this is only a suspicion and it might well be that DH students, despite the discrepancy in their training times and level of proficiency displayed, could also reach levels of competency similar to those of the dental students with an equally low number of training hours. This is one avenue of investigation that is worth following up.

Possible limiting factors in this study such as the clinical test site (university skills lab, not the individual DH schools) and the instrument set provided (university instruments, not the students' own), however, proved to be no hindrance to the DH students in group 2a. Therefore, these factors may be deemed of little relevance when evaluating the results.

Other factors that may be viewed as having a limiting influence on the results are different teaching staff at each institution (pedagogic credentials, years of experience, levels of expertise in scaling/root planing, ability to efficiently train preclinical skills) and a possible diversity in the class composition of the two different DH schools. The entry tests for both programmes are similar but administered by the faculty of each school for itself. We have neither data on the pre-admission testing process for the DH students nor the minimal results required for admission to their programmes nor the range of scores for each class

on these tests. In a follow-up study, not only should these important factors be taken into consideration, but additional data may provide clarity as to whether there is in fact a fundamental difference between these two DH schools' student populations.

Finally, it must be stated that the results of this study have no predictive value for clinical success. While the choice of tooth for testing in this study had a simple anatomy and was easy to access, both the feel of human dentin/cementum/enamel and concrement cannot be truly simulated on a typodont model. Further, previous studies have shown that even skilled clinicians have difficulty removing concrement from subgingival root surfaces, whether on patients or on a typodont model (Rabbani et al. 1981; Brayer et al. 1989; Gartenmann et al. 2018). This may also explain the less than stellar results achieved by the experienced dental hygienists. This cohort had no recent experience working on plastic teeth and no time to practice before the 5-minute exercise. Therefore, it is not surprising that this cohort did not obtain optimal results.

Within the limitations of this study, we have shown that 8.5 hours of preclinical training was sufficient for dental students to remove concrement from an upper right maxillary canine to a level equal to or greater than DH students receiving 80 or 64 hours of preclinical training in scaling/root planing. These results point to the possibility of reducing the number of hours allocated to learning this preclinical skill by both dental and DH students and reallocating that time to other areas of the curriculum.

Conflict of interest and source of funding statement

The present study was undertaken without external funding. All authors state that they have no conflict of interest.

Zusammenfassung

Einleitung

Zahnmedizinstudenten der Universität Zürich erhalten vor dem Eintritt in die Klinik 8,5 Stunden Unterricht in Scaling und Wurzelglätten. Studenten einer Dentalhygieneschule dagegen erhalten ein Vielfaches an Übungsstunden. Diese Studie untersucht und vergleicht das vorklinische Können von Zahnarzt- und Dentalhygienestudenten.

Material und Methoden

Vierunddreissig Studenten/-innen und 20 Dentalhygieneschülerinnen (DH) zweier verschiedener Institutionen in Zürich führten an einem standardisierten oberen Eckzahn im Phantomkopf das Scaling und Wurzelglätten durch. Ihnen wurde fünf Minuten Zeit gegeben. Den Probanden wurde die Wahl des Instrumentes aus ihrem Set (Gracey 5/6, 7/8, 11/12, 13/14 oder Deppeler M23A [Universalkürette]) selbst überlassen. Eine positive Kontrollgruppe bestand aus erfahrenen Dentalhygienikerinnen, eine negative Kontrollgruppe bestand aus Laien. Die Testzähne waren mit schwarzem Nagellack vom Apex bis 5 mm koronal der Schmelz-Zement-Grenze bestrichen. Nach der Instrumentation wurden die Zähne entfernt, gescannt und planimetrisch erfasst. Der prozentuale Anteil der gereinigten Oberflächen wurde berechnet und statistisch ausgewertet (Kruskal-Wallis-Test, Conover's Test für paarweise Vergleiche).

Resultate

Zahnmedizinstudenten erreichten die höchste Reinigungseffizienz (80,6%) gefolgt von erfahrenen Dentalhygienikerinnen (65,3%), Dentalhygieneschülerinnen (62,0%) und Laien (26,7%). Die Analyse der Reinigungseffizienz von Schülerinnen unterschiedlicher Dentalhygieneschulen ergab einen signifikanten Unterschied ($p < 0{,}001$).

Diskussion

Trotz der sehr begrenzten Trainingsdauer konnten Zahnmedizinstudenten vergleichbare oder sogar bessere Resultate beim Scaling und Wurzelglätten erzielen als Dentalhygieneschülerinnen mit wesentlich mehr Übungsstunden. Diese Ergebnisse könnten die Schlussfolgerung zulassen, die Anzahl an praktischen Übungsstunden in den Dentalhygieneschulen zu reduzieren und stattdessen die Unterrichtsstunden auf andere Fächer des Curriculums zu verteilen.

Résumé

Introduction

Les étudiants en médecine dentaire de l'Université de Zurich suivent 8,5 heures de formation préclinique dans les domaines du détartrage et du surfaçage des racines. Par contre, dans les écoles d'hygiénistes dentaires, les élèves ont beaucoup plus d'heures consacrées aux exercices pratiques. Cette étude investigue et compare les compétences précliniques des étudiants en médecine dentaire et en hygiène dentaire.

Matériel et méthodes

34 étudiants en médecine dentaire et 20 étudiantes en hygiène dentaire (HD) de deux institutions zurichoises différentes ont effectué un détartrage et surfaçage standardisé d'une canine supérieure sur tête fantôme. Ce travail devait être réalisé en cinq minutes. Les participants choisissaient eux-mêmes dans leur équipement les instruments à utiliser (Gracey 5/6, 7/8, 11/12, 13/14 ou curette universelle Deppeler M23A). Un groupe témoin positif était constitué d'hygiénistes dentaires expérimentées, et un groupe témoin négatif était composé de profanes. Les dents à traiter avaient été recouvertes d'un vernis à ongle noir de l'apex jusqu'à 5 mm coronalement par rapport à la limite émail-cément. Après l'instrumentation, les dents ont été retirées, scannées et enregistrées par planimétrie. Le pourcentage de surface nettoyée a été calculé et évalué statistiquement (test de Kursaal-Wallis, test de Conover pour les comparaisons par paires).

Résultats

Les étudiants en médecine dentaire ont obtenu l'efficience de nettoyage la plus élevée (80,6 %), suivis des hygiénistes dentaires expérimentés (65,3 %), des étudiantes en hygiène dentaire (62,0 %) et des non-spécialistes (26,7 %). L'analyse de l'efficience du nettoyage des élèves des différentes écoles d'hygiène dentaire a mis en évidence une différence significative ($p < 0{,}001$).

Discussion

En dépit de la durée très limitée de leur formation, les étudiants en médecine dentaire ont obtenu en matière de détartrage et de surfaçage des résultats comparables, voire meilleurs que les élèves en hygiène dentaire, qui avaient pourtant bénéficié d'un nombre d'heures de pratique beaucoup plus élevé. Ces résultats pourraient permettre de conclure que dans les écoles d'hygiène dentaire, le nombre d'heures de cours pratiques pourrait être réduit, et que ces heures pourraient être attribuées à d'autres matières du programme.

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